FIRST RECORD OF REVERSAL IN *SYMPHURUS VANMELLEAE* (PLEURONECTIFORMES: CYNOGLOSSIDAE), A DEEP-WATER TONGUEFISH FROM THE TROPICAL EASTERN ATLANTIC

by

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ABSTRACT. - A reversed specimen of *Symphurus vanmelleae* is described from off the coast of Senegal. This specimen represents the first recorded occurrence of reversal in this species and the first record of reversal occurring in a species of *Symphurus* inhabiting either a deep-water or a tropical environment. This is only the fifth known reversed specimen of a symphurine tonguefish and the first reported occurrence of reversal for any of six species of *Symphurus* occurring in the eastern Atlantic region.

RÉSUMÉ. - Un spécimen inversé de *Symphurus vanmelleae* est décrit des côtes du Sénégal. C'est le premier cas rapporté d'une réversion chez cette espèce et c'est aussi la première description d'une réversion chez une espèce de *Symphurus* en eau profonde ou tropicale. C'est seulement le cinquième spécimen inversé connu de Symphurinae et le premier cas de réversion pour l'une des six espèces de *Symphurus* vivant dans l'Atlantique Est.

Key-words. - Pleuronectiformes, Cynoglossidae, *Symphurus vanmelleae*, Tonguefish, ASE, Tropical Atlantic, Reversal.

Tonguefishes of the genus *Symphurus* (Cynoglossidae) are small- to moderate-sized, sinistral, flatfishes occurring throughout temperate and tropical oceans. *Symphurus vanmelleae* Chabanaud, 1952 (Fig. 1A) is one of six symphurine tonguefishes known from eastern Atlantic waters (Munroe, 1990). This moderate-sized (to ca. 118 mm SL) and relatively littleknown species (ca. 75 or fewer specimens in fish collections) occurs in bathyal depths (260-945 m) on the outer continental shelf and upper continental slope in the tropical eastern Atlantic from approximately 14°N to 12°S latitude (Munroe, 1990).

In 1992, while examining fishes in the Muséum national d'Histoire naturelle (MNHN) in Paris, I discovered a reversed (dextral) specimen (MNHN 1987-998) of *S. vanmelleae*. This specimen (Fig. 1B-D), an adult male measuring 105 mm in total length (caudal deformity precludes accurate measurement of standard length), was collected off Senegal at a depth of 600 m. Size, depth, and capture location are within respective ranges reported for the species (Munroe, 1990).

RESULTS

Except for obvious reversal in lateral pigmentation, ocular- and blind-side pigmentation (Fig. 1B-C) is otherwise similar to that observed in non-reversed specimens (Munroe, 1990). The ocular (right) side is uniformly dark brown with a single, darker, longitudinal

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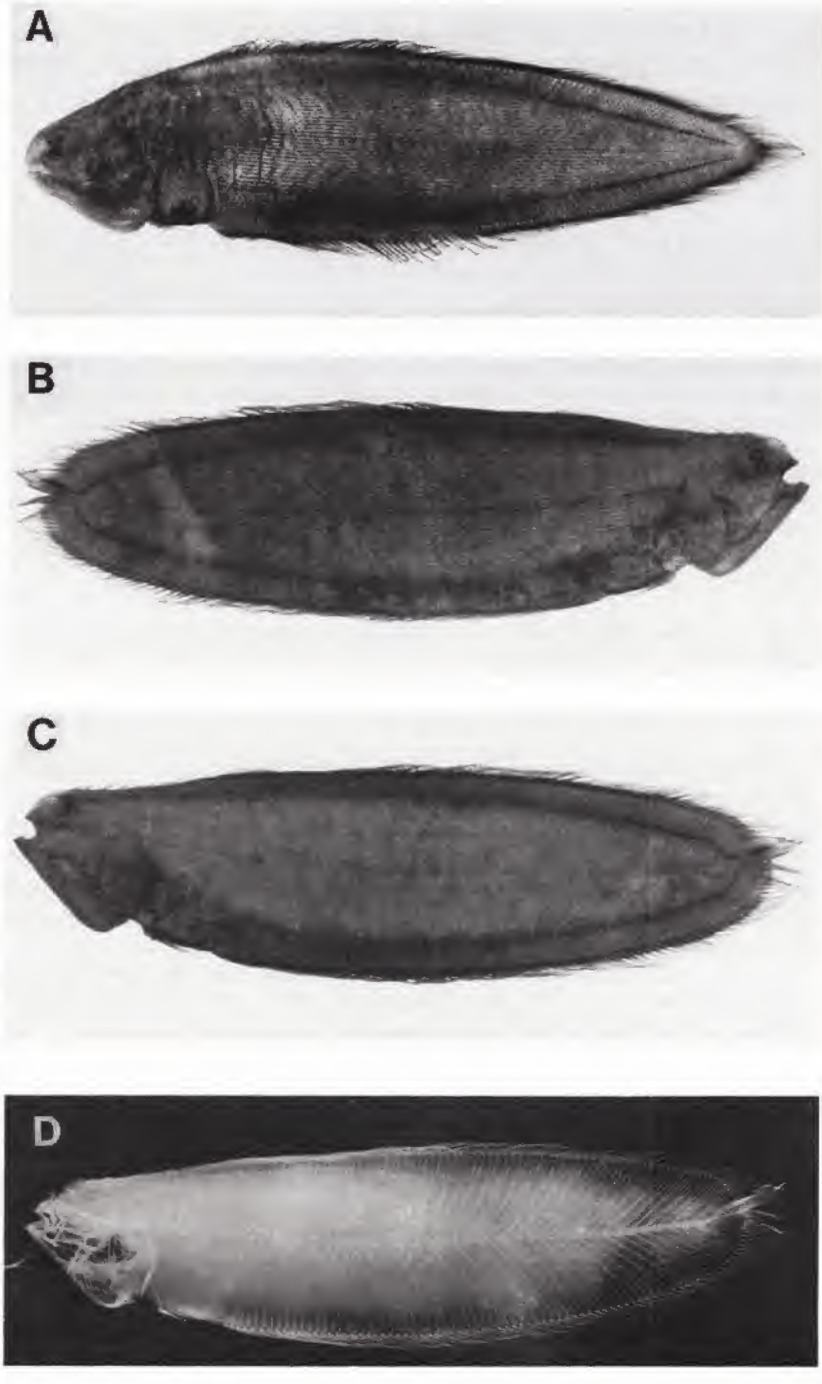
A
B
C
D

stripes along the dorsal and ventral regions of the body overlying the proximal pterygiophores of the dorsal- and anal-fin rays. The blind (left) side is uniformly tan and also has the single, darker, longitudinal stripes along the dorsal and ventral body regions overlying the proximal pterygiophores of the dorsal- and anal-fin rays (both pigmentation features are characteristic for this species). The darkly-pigmented peritoneum is visible through the abdominal wall on both sides of the body.

Externally, obvious morphological deformity is evident in the caudal region of the body. The posterior one-fourth of the fish is exaggeratedly rounded and somewhat broader compared to the tapered shape usually encountered in this species (compare Fig. 1A, 1B). Posterior finrays of both dorsal and anal fins are aberrant in two respects. They are aligned on the same vertical plane with those of the caudal fin, and their distalmost tips extend posteriorly to a length about equal with that of the distal tips of the caudal-fin rays. Typically, bases of the posteriormost dorsal- and anal-fin rays are aligned in a successive series extending posteriorly more or less on the same horizontal plane. Also, in normal specimens, the distalmost tips of the caudal-fin rays extend well beyond those of the posteriormost dorsal- and anal-fin rays. Vertical alignment of the posteriormost dorsal- and anal-fin rays with posterior tips extending to a point equal with those of the caudal-fin rays gives the entire caudal region of the body its rounded, truncate appearance.

A caudal fin is present and conjoined with the posterior dorsal and anal fins as in other specimens. However, the caudal fin is even less discernible from the terminal portions of the dorsal and anal fins than usual, because the finrays are crowded together with some overlying others (Fig. 1B). Furthermore, the distalmost tips of the caudal-fin rays are not readily distinct as these do not extend posteriorly beyond those of the posteriormost dorsal- and anal-fin rays.

Unlike non-reversed specimens in which the right eye migrates, in this individual the left eye has migrated to the right side of the head. The anus, visceral organs, and pelvic fin of the reversed specimen, however, retain the positions encountered in sinistral specimens of this species. The anus is located on the right side of the body (ocular surface of reversed specimen) slightly dorsal to the ventral midline of the body. The liver retains its usual position on the left side of the abdominal cavity opposite the intestinal coils. Characteristic for the species, there is also a single pelvic fin with four finrays increasing in length from dorsalmost to ventralmost. Location and alignment of the pelvic fin, with respect to the ventral midline of the body, is also consistent with the condition in non-reversed specimens (i.e., the longest finray is the ventralmost).

Examination of a radiograph of this specimen (Fig. 1D) reveals unexpected differences in some meristic features, and also considerable deformity of the posterior vertebral column. It is interesting to note that these vertebral anomalies are not accompanied by the coloration anomalies reported for other flatfishes (Gartner, 1986). Meristic features for 64 nonreversed specimens of *S. vanmelleae* are: pattern of interdigitation of dorsal-fin pterygiophores and neural spines (ID pattern) usually 1-2-2-1-2-2-2 or 1-2-2-2-1-2-2 (see Munroe [1992] for detailed information on this character); 10 abdominal vertebrae; 46-49 caudal vertebrae; usually 5 hypurals (48/60 specimens); 101-108 dorsal-fin rays; 86-93 anal-fin rays; 4 pelvic-fin rays; and 12 caudal-fin rays. In contrast, the ID pattern (1-2-2-1-3-1-3) of the

Fig. 1. - A: Ocular-side view of non-reversed specimen of *Symphurus vanmelleae* (IOS Discovery Station 10873, female, 103 mm SL; West Africa 14°49.04'N, 17°43.69'W). B-C: Ocular- and blind-side views of reversed specimen of *S. vanmelleae* (MNHN 1987-998, male, 105 mm total length; west Africa, ca. 13°N, 15°W). D: Radiograph of reversed specimen of *S. vanmelleae* (MNHN 1987-998) showing aberrant condition of caudal vertebrae, caudal fin, and posteriormost regions of dorsal and anal fins.

reversed specimen is unusual in having three pterygiophores inserted into interneural spaces five and seven (versus the usual condition of one or two inserted into interneural space five, and two inserted into interneural space seven), and in having only one pterygiophore inserted into interneural space six (versus two pterygiophores otherwise inserted into this interneural space).

The 10 abdominal vertebrae are characteristic for the species. Counts of caudal vertebrae and finrays for this specimen are estimated because the caudal region is deformed (described below), which precludes accurate counts. The posteriormost caudal vertebrae are aberrant and can not be interpreted accurately. There are approximately 39 caudal vertebrae in this specimen if all elements are counted as single vertebra (versus 46-49 in other specimens), but some elements included in this count may be the result of fusion of several centra (described below). Counting posteriorly from the last abdominal vertebrae, the specimen has 34 normal-shaped caudal vertebrae. All caudal vertebrae posterior to these are aberrant (Figs 1D, 2). The 35th vertebra has the single neural and haemal spine typical of the preceding 34 caudal vertebrae, however, its centrum is foreshortened, with its posterior edge upturned slightly. Caudal vertebra 36 is unusual in that it has three bent and somewhat wavy (vs. normally straight and smooth) neural spines and three haemal spines. This centrum is also aberrant in that it is longer than usual with a large extension of bone on its ventral surface. Its large size, ventral deformity, and additional neural and haemal spines may result from fusion of three or more centra. Caudal vertebra 37 is also unusual in that it lacks a haemal spine and has one neural spine fused to the centrum at its base, with a second neural spine fused to the first at a level about equal with one-fourth of its length. There is a small piece of bone situated between dorsal aspects of centra 37 and 38 that may be the remnant of another centrum, but it is impossible to ascertain this. Caudal vertebra 38 is aberrant in having four neural (two of which are fused) and four haemal spines (anterior two fused and only partially developed, whereas the two posterior spines are separate and fully developed), and this centrum is also relatively elongate with the posterior region narrow compared with a typical centrum. The shape of this bone is suggestive of fusion of four or more centra. The shape of the 39th caudal vertebra, the terminal vertebra in this specimen, is not characteristic of the terminal centrum typically for this species. A single epural and parhypural which support caudal-fin rays, as is typical for the species, are both present. However, there are only three (vs. usually five) hypurals evident. If my interpretation of vertebral fusion is correct, then the total number of caudal vertebrae in this individual, including counting the bone between vertebrae 37 and 38 as a centrum, would be 45, which is close to the range normally expected in *S. vanmelleae*. (Because of deformity, it is not possible to accurately identify osteological features of the caudal skeleton beyond those mentioned above without clearing and staining the specimen).

Accurate counts of dorsal- and anal-fin rays for this specimen, although difficult to make, appear to be close to ranges normally expected for the species. There are 97 dorsal-fin rays with typical spacing between finray bases (vs. 101-108 in other specimens). There appear to be three additional finrays in the posteriormost section of the fin that are packed tightly together and which overlap slightly. The anal fin has 83 finrays with normal spacing (vs. 86-93 in other specimens). An additional three to six finrays in the posteriormost region of the fin, some with bases overlapping slightly, have much narrower and irregular spacing between their bases. The caudal fin has the 12 finrays typical of the species; however, it is greatly deformed. Eleven finrays are nearly equal in length, but the fourth from the ventral margin is somewhat shorter, being only about one-half the length of the others. Typically, caudal-fin rays of this species are evenly spaced, extending posteriorly beyond the tips of the posteriormost dorsal- and anal-fin rays, and are arranged parallel to each other. In this speci-

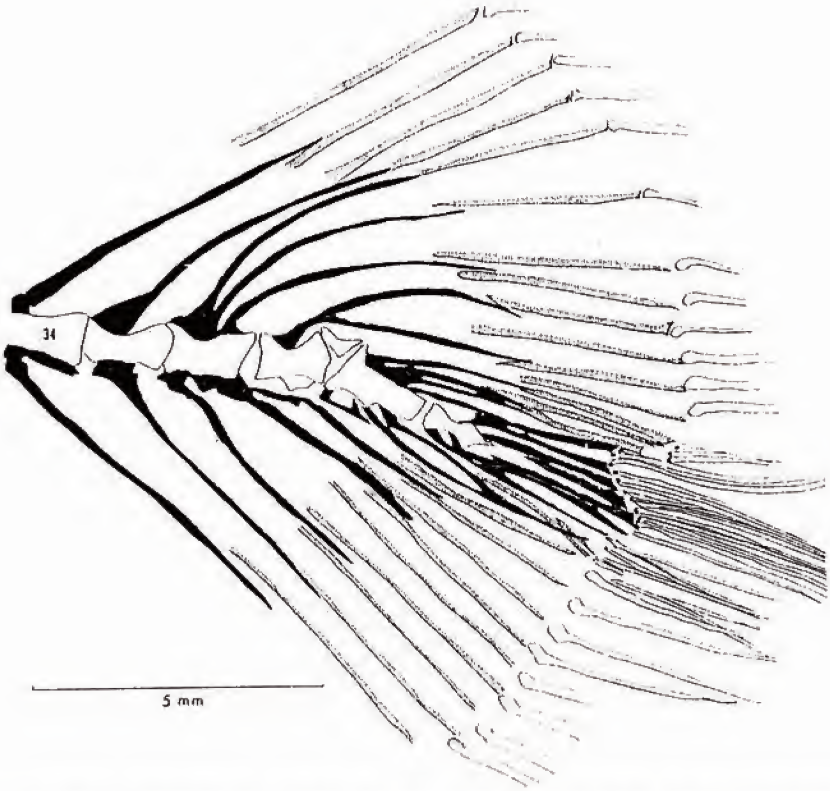

Fig. 2. - Schematic representation of caudal vertebrae, hypural skeleton, caudal fin, and posteriormost regions of dorsal and anal fins of reversed specimen of *Symphurus vanmelleae* (MNHN 1987-998, male, 105 mm total length; west Africa, ca. 13°N, 15°W). Vertebrae white; neural and haemal spines, hypurals, epural and parhypural black; pterygiophores stippled; finrays white.

men, the caudal-fin rays have irregular spacing basally with the finrays packed tightly together, but not parallel to each other. The three dorsalmost caudal-fin rays curve dorsally, while the nine ventralmost finrays curve ventrally, essentially dividing the caudal fin into two unequal sections. Of interest is that dorsal-fin rays 91-101 and anal-fin rays 70-89 are aligned essentially on the same plane as those of the caudal fin, which gives the posterior margin of the body its truncate appearance. This modified arrangement of dorsal-, anal-, and caudal-fin rays has the effect of broadening the entire posterior region of the body and this expanded complex may have functioned in life as an enlarged caudal fin.

DISCUSSION

This specimen of *S. vanmelleae* is significant because it represents the first recorded occurrence of reversal in this species, and it is only the fifth reported reversed specimen of a symphurine tonguefish. This specimen is also the first reported incidence of reversal in an eastern Atlantic species of *Symphurus*, and the first record of reversal occurring in a species of *Symphurus* inhabiting either a deep-water or a tropical environment.

Previous reports of reversed tonguefishes are those of species occurring in temperate waters of the western Atlantic and eastern Pacific. Chabanaud (1948) recorded the first reversed specimen of *Symphurus*, taken off the coast of Louisiana, that he identified as *S. plagiusa* (Linnaeus). This specimen was later reidentified (Munroe, 1991) as *S. civitatium* Ginsburg. Other reversed tonguefishes are a partially ambicolorate specimen of *S. diomedeanus* (Goode and Bean, 1885) collected off the Gulf Coast of Florida (Moe, 1968), a completely reversed specimen of *S. plagiusa*, which was taken in the Duplin River estuary, Georgia (Dahlberg, 1970a), and a reversed specimen of the California tonguefish, *S. atricaudus* (Jordan and Gilbert), trawled off Long Beach, California (Telders, 1981). Reversed specimens of *S. civitatium* and *S. diomedeanus* lack any pelvic fins, whereas, the reversed specimens of *S. plagiusa* and *S. atricaudus*, as well as that of *S. vanmelleae* in this study, have the single pelvic fin characteristic of those species present and fully developed. Of five known reversed specimens of tonguefishes, the only one in which *situs inversus viscerum* (reversal of relative positions of liver and intestinal coils) occurs is that of *S. plagiusa* (Dahlberg, 1970a).

Earlier investigations that examined differences in frequencies of anomalies in various groups of flatfishes (Dawson, 1962; Haaker and Lane, 1973; Telders, 1981) suggested that these differences were related to the degree of specialization represented by the taxonomic group under study. Anomalies were thought to occur more frequently in less specialized flatfishes, such as the bothids or pleuronectids, and less frequently in more derived groups including the soleids and cynoglossids. Gartner (1986), in summarizing results from the literature, invoked an ecological hypothesis to explain the differences in frequency of occurrence of anomalies observed in different groups of flatfishes. He noted that reversals and other abnormalities were reported most frequently for those species of flatfishes inhabiting shallow-water areas (most often < 5 m bottom depth) in temperate or boreal environments. Consistent with this observation, reversed individuals of *Symphurus*, except for the specimen of *S. vanmelleae*, belong to species whose center of abundance occurs in 100 m or less, and whose center of distribution is located in temperate latitudes (Munroe, 1992). Most *S. diomedeanus* are collected between 20 and 100 m, while the majority of populations of *S. civitatium*, *S. atricaudus*, and *S. plagiusa* are usually found in much shallower coastal waters and estuarine embayments.

Although causes of reversals and other abnormalities in flatfishes remain uncertain, variations in light and temperature regimes during larval development have been shown to induce abnormalities (literature summarized in Gartner, 1986). Temperature variations during development may also account for the fact that abnormalities occur more frequently in flatfishes from more northern climates where seasonal temperature extremes are more pronounced. Dawson (1962), for example, thought that lower temperatures during larval development most likely accounted for the greater frequency of abnormalities reported from flatfishes collected along the east coast of the United States when compared with data for conspecifics taken in the Gulf of Mexico.

Flatfishes that spawn in shallow waters probably experience the greatest extremes in light intensity and temperature fluctuations during development, and it is not surprising to find that the majority of anomalies have been recorded for those species residing in these dynamic environments. Eggs and larvae of many flatfishes that are deep-dwelling as adults are pelagic, and like inshore species, may also be subjected to extremes of light and temperature in surface waters. Yet, abnormalities in these deep-dwelling species are relatively unknown (Gartner, 1986). Infrequent observation of anomalies in deeper-dwelling species is somewhat inexplicable, and may not be entirely attributable to artifacts of fishing effort.

Anomalies in deep-water flatfishes may be observed only rarely because deep-water pleuronectiforms may spawn while surface temperatures are relatively stable, and also because anomalous pigment patterns may be reversed after juveniles settle into an environment with comparatively stable light regimes (Gartner, 1986).

For symphurine tonguefishes, reversals and other abnormalities occur infrequently (Dawson, 1964; Dahlberg, 1970a, 1970b; Telders, 1981; Gartner, 1986). Possibly, reversal is a rare phenomenon in this pleuronectiform subfamily, or perhaps, as others have pointed out, reversed tonguefishes go unnoticed simply because less attention is paid to these relatively small, commercially unexploited flatfishes. For whatever reason, reversed specimens of tonguefishes are encountered only rarely, and previous records are only for species commonly taken in relatively shallow waters in temperate latitudes. Capture, therefore, of any reversed tonguefish is fortuitous, more so for a rarely-collected, deep-dwelling, tropical species, such as the eastern Atlantic *S. vanmelleae*.

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